REMARKS

This Amendment is fully responsive to the non-final Office Action dated June 22, 2009, issued in connection with the above-identified application. Claims 1-6 are pending in the present application. With this Amendment, claims 2-6 have been amended; and claim 1 has been canceled without prejudice or disclaimer to the subject matter therein. No new matter has been introduced by the amendments made to the claims. Favorable reconsideration is respectfully requested.

To facilitate the Examiner's reconsideration of the present application, the Applicants have provided replacement portions for the specification and a substitute abstract. The changes to the specification and the abstract include minor editorial and clarifying changes. No new matter has been added by the changes made to the specification and the abstract.

In the Office Action, claims 3-6 have been rejected under 35 U.S.C. 112, second paragraph, as being indefinite. Specifically, the Examiner indicates that the claims include redundant features, which creates confusion. The Applicants have amended the claims to remove the redundant features and to clarify the claims. Withdrawal of the rejection under 35 U.S.C 112, second paragraph, is respectfully requested.

In the Office Action, claims 1, 3 and 4 been rejected under 35 U.S.C. 103(a) as being unpatentable over Tsukamoto (U.S. Publication No. 2004/0026381, hereafter "Tsukamoto") in view of Terada (U.S. Patent No. 5,155,329, hereafter "Terada") or Chou et al. (U.S. Patent No. 5,961,859, hereafter "Chou"). The Applicants have canceled independent claim 1, thereby rendering the above rejection to that claim moot. Additionally, claim 3 has been rewritten in independent form, and the Applicants assert that claim 3 includes features not believed to be disclosed or suggested by the cited prior art. Claim 3 recites the following features:

"[a] laser welding method, comprising:

varying a waveform and a frequency of a laser output in a controlled manner so as to prevent occurrence of weld defects;

detecting a time change in the light emission strength of a plasma or a plume generated from a laser welded portion;

setting an arbitrary threshold value to the time change in the light emission strength of the plasma or the plume; and

setting a laser output variation condition so that a sum of time at which the light emission strength becomes the threshold value or less becomes minimum."

The features recited above in independent claim 1 are fully supported by the Applicants' disclosure (see e.g., pg. 8, line 2 to pg. 9, line 19; and Fig. 10).

The present invention (as recited in independent claim 3) is directed to a method that periodically varies a laser output, and makes the frequency of the laser output match a natural frequency of a wave generated on a surface of a molten pool so as to prevent weld defects. Further, the present invention controls a waveform of the variation in the laser output so as to further heighten the defect preventing effect.

That is, since the preventing effect of the weld defect greatly depends on "a waveform of the variation" and "a frequency of the variation" in the laser output, it is important to optimize conditions of the variation in the laser output. The method of the present invention (as recited in independent claim 3) uses an optimum frequency of the variation in the laser output that prevents the occurrence of the weld defects more simply and securely.

In the Office Action, the Examiner relies primarily on Terada and Chou for disclosing or suggesting all the features of claim 3.

In the Office Action, the Examiner indicates that Terada discloses that the welding conditions are determined by the light intensity emitted from the welds. However, Terada only discloses that "the behavior of laser beam welding can be deduced from monitoring the intensity of light of a predetermined wavelength immediately before a rise in intensity of the pulsating laser beam, that is for determining the minimum emission intensity." Terada fails to disclose or suggest "the optimum conditions" of laser output variation so as to prevent the occurrence of the weld defects.

Moreover, Terada discloses monitoring the welding condition locally at any time but does not determine the optimum condition and the optimum frequency of the variation of the entire welding. Accordingly, the present invention (as recited in independent claim 3) is distinguishable from Terada in that the present invention provides a degree of correlation between the variation in the plasma signal and the output variation under the optimum frequency conditions of laser output variation. Furthermore, the welding quality considered by Terada considers penetration depth, which does not decrease welding defects such as porosity, blowhole and crack.

In the Office Action, the Examiner states that Chou discloses welding conditions that are determined by the light intensity of the light emission of the welded portion. However, similar to Terada, Chou monitors the welding condition at any time, but does not determine the optimum condition and the optimum frequency of the variation of the entire welding.

The Examiner states that Chou discloses that strength of plasma can reach a threshold value that would be indicative of the weld problem. However, the threshold disclosed in Chou is a digitized plasma intensity of 25 counts irrespective of intensity saturation. Thus, it is natural that the strength of the plasma reaches a threshold value (see e.g., column 5, lines 16-18).

However, Chou discloses that the time duration of the dip during at least 30 ms is considered an important indicator of the localized weld problem (see e.g., lines 49 to 64, column 9) and that a sudden decrease in the weld dimension, such as caused by a momentary decrease in the laser beam power that does not last for more than 30 ms, does not necessarily result in a bad weld (see e.g., lines 66, column 9 to line 2, column 10).

In the present invention, the occurrence of weld defects is evaluated by the dip during 2ms or more, which conflicts with Chou. Moreover, Chou monitors the welding condition locally at any time but does not determine the optimum condition and the optimum frequency of the variation of the entire welding. Furthermore, the welding quality considers in Chou relates to depth, which does not decrease welding defects such as porosity, blowhole and crack.

Based on the above, no combination of Tsukamoto, Terada and Chou would result in, or otherwise render obvious, independent claim 3. Likewise, no combination of Tsukamoto, Terada and Chou would result in, or otherwise render obvious, claim 4 at least by virtue of its dependency from independent claim 3.

In the Office Action, claims 2, 5 and 6 have been rejected under 35 U.S.C. 103(a) as being unpatentable over Tsukamoto in view Terada or Chou, and further in view of Kearney (U.S. Patent No. 4,446,354).

The Applicants assert that the cited prior art fails to disclose or suggest all the features recited in independent claim 2 for at least the reasons noted above for independent claim 3. That is, independent claim 2 includes similar features of independent claim 3, and (as noted above) no combination of Tsukamoto, Terada and Chou would result in, or otherwise render obvious, independent claim 3. Accordingly, no combination of Tsukamoto, Terada and Chou would result in, or otherwise render obvious, independent claim 2 for the same reasons noted above for

independent claim 3. Moreover, Kearney fails to overcome the deficiencies noted above in Tsukamoto, Terada and Chou.

Specifically, Kearney discloses monitoring a weld bead by detecting "the special spectrum" of radiation and comparing the amplitude of the spectrum with a known reference. In the present invention (as recited in independent claim 2), a laser output gyrating condition is decided by analyzing the frequency characteristics of "a time change (variation)" in light emission strength of a plasma or a plume, not the amplitude of light emission strength. And, the light of the specific wave length is not detected.

Accordingly, no combination of Tsukamoto, Terada, Chou and Kearney would result in, or otherwise render obvious, independent claim 2. Likewise, no combination of Tsukamoto, Terada , Chou and Kearney would result in, or otherwise render obvious, claims 5 and 6 at least by virtue of its dependency (directly or indirectly) from independent claim 2.

In light of the above, the Applicants respectfully submit that all the pending claims are patentable over the prior art of record. The Applicants respectfully request that the Examiner withdraw the rejections presented in the outstanding Office Action, and pass this application to issue. The Examiner is invited to contact the undersigned attorney by telephone to resolve any remaining issues.

Respectfully submitted,

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September 22, 2009